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### THREE NEW SPECIES OF HOLOSTOMIDAE

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Very few studies have been made on holostomes from North America. Only a few scattered records, principally of European species, have been reported from this continent. Practically no work has been done on the endemic species. A survey of the records of species known to exist here, either in larval form or as adults, shows the limitations of this work.

Leidy (1856) and Stiles and Hassall (1894:248) recorded the occurrence of *Strigea* (*Holostomum*) *cornu* Nitzsch, a European species from the intestine of *Ardea herodias*. At the same time Leidy described another form, *Holostomum nitidum*, from the intestine of *Rana pipiens*, which Stafford (1902:724) maintains is a distome and should not be classed in this group. In 1858, Leidy reported *Diplostomulum grande* Diesing from *Strix nivea* and also noted later (1890:416) *Tetracotyle typica* Diesing from snails, *Lymnaea catascopium* and *Physa heterostropha*. Rettger (1897:224) mentions a larval holostome with some notes on its life history but does not describe or name it. *Diplostomulum parvalum* has been described by Stafford (1904:494) as a new species from fishes of Canada. Cooper (1915:191) reported finding *Diplostomulum cuticola* (v. Nordm.) encysted in the mesenteries, livers and kidneys of several Canadian fishes and *D. volvens* v. Nordm in the lens of the eye of *Micropterus dolomieu*. *Hemistomum craterum* was described from the muskrat by Barker and Noll (1915:191), and according to Stiles and Hassall (1894:248), an unnamed species of this genus was recorded from *Didelphis virginiana* by C. Curtice. *Polycotyle ornata* Willemoes-Suhm was taken from *Alligator lucius* (cited after Ward 1918:410). Faust (1917:62) in his life history studies has thrown much light on the development of holostomes. In this work he described three larval forms, *Cercaria ptychocheilus*, *Cercaria* (*Tetracotyle*) *flabelliformis*, from snails and *Tetracotyle pipientis* from *Rana pipiens*.

During the autumn of 1919, several loons (*Gavia immer*) were seen in the vicinity of Stillwater, Oklahoma, which is an unusual occurrence. In October of that year three loons were killed and brought to the laboratory. These birds harbored two species of holostomes, one belonging to the genus *Strigea* Abildgaard 1790, and the other to *Hemistomum* Diesing 1850. These forms proved to be new species and

were reported in a preliminary note (Guberlet, 1922). On Nov. 3, 1921, a ring-billed gull (*Larus delawarensis*) was killed in the same locality. This bird also yielded two species of holostomes. One was *Strigea aquavis*, the same species as taken from the loon, and the other a new species of Hemistomum.

*Strigea aquavis* nov. spec. (Figs. 1-3)

A superficial study of living specimens showed them to be sluggish. The movements of the body were very slow and apparently the worms can make but little progress in moving about on a solid sub-stratum. The principal movements displayed were slow contractions and expansions. The lamellae of the adhesive organ move about somewhat, apparently acting to some extent as feelers. They may spread out and cover an area considerably larger than the mouth of the cup-like cephalic region.

The bulbular cephalic region is opaque in the living specimen. The cylindrical caudal region is opaque when viewed from dorsal or ventral surfaces. In lateral view the upper half is transparent, while the lower half, containing the alimentary tract, vitellaria, and other organs, is opaque. The testes and ovary are also more or less colorless but their outlines can be distinctly made out. Laurer's canal may be seen coming from the oviduct near the ovary and extending to the dorsal surface. Convolutions of the uterus may be observed in the region anterior to the ovary. The eggs are yellowish brown in color.

Specimens of this trematode range in length from 2.5 to 3.5 mm. A definite constriction marks the division between the cephalic and caudal regions. The cup-shaped cephalic region, 0.5 to 0.75 mm. in length and 0.6 to 0.9 mm. in diameter, contains the oral sucker, acetabulum, and leaf-like adhesive organ. Within the caudal region, 2 to 3 mm. in length and 0.45 to 0.55 mm. in diameter, are located the reproductive organs, the excretory system and the intestinal crura.

The oral sucker, 110 to 137 $\mu$  in diameter, is terminal, being located inside of the cephalic region. The acetabulum, 143 to 192 $\mu$  in length and 126 to 154 $\mu$  in diameter, is located posterior to the oral sucker inside of the cephalic region. Attached to the bottom, inside of the cup-like cephalic region, is the hold-fast organ, or adhesive disc, lying directly ventral to the acetabulum. The lamellae, or leaf-like papillae, that form the disc extend forward and protrude beyond the rim of the cup. These lamellae are cleft for some distance, which may give the appearance of the presence of several structures, but as a rule the protuberances are so closely associated that the divisions are not apparent. Slightly posterior to the base of the disc is the adhesive gland, 134 $\mu$  in length and 210 $\mu$  in width.

The mouth is located in the oral sucker. Directly posterior to it is the small pharynx, 70 to 88 $\mu$  in length and 55 to 70 $\mu$  in diameter. There is practically no esophagus as the alimentary canal bifurcates almost immediately forming the intestinal crura. These pass on either side of the acetabulum and downward to the ventral region of the body where they lie between the vitellaria and extend to the posterior end of the body.

The excretory system in this species is difficult to make out on account of the exceedingly large and numerous excretory spaces that fill in the areas around the various organs. In the living specimen certain parts could be traced only with difficulty because of the opacity of the lower half of the worm. The larger canals could be made out to some extent by detecting movements of small semi-transparent granules flowing in the liquid contents. Two principal lateral canals form the basis for the system and these are united by a network of smaller canals. The lateral canals unite in the posterior end of the body and empty at the common excretory pore. A complete study of the excretory system could not be made on account of a lack of suitable material.

*Reproduction Organs.*—Two large testes, one in front of the other, are located directly posterior to the ovary. These are irregular in shape and composed of four lobes each; they measure 0.37 to 0.44 mm. in length, 0.296 to 0.44 mm. in width, and 0.30 to 0.33 mm. in thickness. The anterior testis is slightly smaller than the measurements given. Vasa efferentia arise from the anterior edge of each testis. The duct from the anterior testis forms a seminal reservoir ventral to the ovary. From this reservoir the duct passes posteriad, and unites with the one from the posterior testis, forming the vas deferens which passes posteriorly to the vesicula seminalis. The vesicula seminalis empties into an ejaculatory pouch which has some of the characteristics of a cirrus pouch. This structure is 0.162 to 0.185 mm. in length and is 0.088 mm. in diameter. It has a heavy wall but it is not muscular. There is not a true cirrus. This modification of the vesicula seminalis approaches somewhat the structure of a cirrus pouch. Since this is not a true cirrus pouch it agrees with the characteristics of the genital organs of the Holostomidae, as given by Brandes (1888: 426, 1890: 579) and Lühe (1909: 160). Odhner (1913: 308) and Faust (1921: 82), however, both show the presence of this organ in Cyathocotyle Mühling.

In *Strigea aquavis* there is a modified bursa surrounding the genital cone. During certain movements of the living specimen the cone may be extruded from the pit.

The ovary is dorsal and lies near the middle of the caudal region

of the body. It is somewhat irregular in shape varying in length from 0.14 to 0.25 mm., in breadth 0.2 to 0.247 mm., and in thickness 0.177 to 0.2 mm. The oviduct arises at the posterior dorsal edge of the ovary and passes posteriad for some distance, giving off Laurer's canal almost immediately after leaving the ovary. Laurer's canal extends dorsad to the dorsal surface of the body. The oviduct continues posteriorly and somewhat ventrad to Mehlis' gland, a group of unicellular gland cells which are somewhat scattered and do not form a compact mass. As the oviduct passes through Mehlis' gland it becomes the ootype and at this point receives the vitelline canal. The oviduct upon leaving Mehlis' gland enlarges into the uterus which turns downward between the testes, becomes convoluted and passes anteriad. In the region ventral and slightly anterior to the ovary the uterus becomes thick walled for some distance. The uterus, somewhat convoluted, extends anteriorly almost to the anterior end of the caudal region where it bends back on itself and passes posteriad almost in a direct line to the posterior end of the body where it opens to the exterior through the genital pore in the genital cone. A small sphincter muscle surrounds the vagina in the region of the genital pore.

The vitellaria form a dense layer in the ventral half of the caudal region of the body. Small vitelline canals arise and pass dorsad to form the vitelline reservoir between the two testes. The vitelline duct passes dorsad from the reservoir and empties into the oviduct in the region of Mehlis' gland.

The eggs of *Strigea aquavivis* range in length from 86 to 99 $\mu$  by 56 to 71 $\mu$  in width. An average measurement taken of a large number of eggs gave 92 by 63 $\mu$ .

Hosts: *Gavia immer* and *Larus delawarensis*.

*Hemistomum gavium* nov. spec. (Figs. 10-13)

These are small trematodes 1 to 1.5 mm. in length. The body is in two regions of which the cephalic is much elongated and spoon-shaped, while the caudal is cylindrical. The cephalic region, comprising two-thirds to three-fifths of the length of the body, is 0.30 to 0.40 mm. in breadth and 0.094 mm. in thickness. In this region are located the oral sucker, ventral sucker, adhesive organ, and a pair of suckorial organs. The caudal region, 0.24 to 0.28 mm. in diameter, contains the reproductive organs.

The oral sucker 60 $\mu$  in length and 80 $\mu$  in diameter, is terminal and slightly ventral. Near the center of the cephalic region is located the acetabulum 70 $\mu$  in diameter. The adhesive disc is an oblong, somewhat of a two-lipped structure and more or less muscular. It has a length of 135 to 175 $\mu$  and is 0.1 mm. in breadth. This disc is on the ventral

surface of the cephalic region and located posterior to the acetabulum but does not cover it. Immediately dorsal and posterior to the adhesive disc is the adhesive gland. The lateral suctorial organs are located on either side of the oral sucker. They are apparently adhesive in function and appear somewhat glandular in structure.

The mouth is situated in the oral sucker and immediately posterior to it is the muscular pharynx, 50 to  $70\mu$  in length and  $37\mu$  in diameter. A very short esophagus bifurcates into the intestinal crura which pass to the posterior end of the body, where they terminate beneath the genital depression.

The excretory system terminates in the excretory pore, posterior to the genital pore. There is a slight enlargement where the lateral canals unite to form the common canal. As the canals extend forward they anastomose to form a loose excretory network which is present in nearly all parts of the body. No opportunity was afforded for this study on living material.

The two testes occurring in a series with the ovary are bi-lobed or somewhat dumbbell-shaped. They measure from 0.06 to 0.10 mm. in length, 0.18 to 0.25 mm. in breadth, and 0.13 to 0.15 mm. in thickness. The vas deferens arises at the right cephalic edge of the anterior testis. This duct then passes to the median line, ventral to the testes, and continues posteriad to the vesicula seminalis. A short duct also passes from the posterior testis to the vesicula seminalis. The vesicula seminalis is a large irregular shaped structure, 0.10 to 0.135 mm. in length and the same in width. An ejaculatory duct connects it with the genital pore.

The ovary is located slightly to the left of the median line in the anterior end of the caudal region of the body. This organ has a length of 0.07 to 0.094 mm., a breadth of 0.056 to 0.1 mm., and a thickness of 0.07 to 0.08 mm. The oviduct arises at the medio-posterior edge of the ovary and passes latero-posteriad for a short distance. Laurer's canal is given off from the oviduct and passes almost directly to the dorsal surface, lateral to the ovary. The oviduct continues latero-posteriorly around the anterior testis to Mehlis' gland near the lateral margin, where it forms the ootype. In passing from Mehlis' gland the oviduct becomes the uterus and turns transversely across the body to the median line, bends anteriorly and continues, ventral to the testis, forward to a point just anterior to the ovary. Here it turns ventrad and bends back upon itself and passes in the median line to the posterior part of the body where it opens to exterior through the genital pore. The genital pore is dorsal in a genital depression. The point of exit of the genital pore is located on a slight elevation within the depression.

The vitellaria are numerous and are distributed in small groups. In the caudal region they are ventral and extend from the posterior end forward around testes and ovary. In the cephalic region they are

generally distributed around the adhesive disc and acetabulum and well up toward the anterior end. The vitelline duct arises ventral to the testes and passes upward and enlarges into the vitelline reservoir which is located between the testes. A small duct extends upward from the reservoir and empties into the oviduct in the region of the ootype and Mehlis' gland.

The eggs are thin shelled and few in number, usually not more than a half dozen. They average in size  $85\mu$  in length by  $50\mu$  in breadth.

Host: *Gavia immer*.

*Hemistomum confusum* nov. spec. (Figs. 4-9)

These are small trematodes 1 to 2 mm. in length, with the caudal region of the body slightly longer than the cephalic. The flattened cephalic region measures 0.82 to 0.88 mm. in length, 0.27 to 0.33 mm. in breadth, and 0.08 mm. in thickness. The cylindrical caudal region is 0.88 to 1 mm. in length with a diameter of 0.25 to 0.33 mm.

The oral sucker is terminal and slightly ventral. It is slightly oval in shape with a length of 55 to  $70\mu$  and a breadth of 49 to  $55\mu$ . The acetabulum 60 to  $80\mu$  in diameter is situated in the middle of the ventral surface of the cephalic region. Posterior to the acetabulum is the sucking disc 110 to  $190\mu$  in length and 120 to  $165\mu$  in breadth. This disc is a double organ, or composed of two lateral lips. Above the disc is situated the adhesive gland, which is a double structure  $130\mu$  in length and  $60\mu$  in breadth. The lateral suckorial cups or organs 58 to  $70\mu$  in diameter are located on either side of the oral sucker. They are adhesive in function.

The mouth is located in the oral sucker and immediately posterior to it is the muscular pharynx, 50 to  $60\mu$  in length and 30 to  $50\mu$  in diameter. There is a very short esophagus, as the alimentary canal bifurcates almost immediately after leaving the pharynx into the intestinal crura, which pass to the posterior end of the body.

The excretory system is the same as in *H. gavruium*.

The two testes, unequal in size, are slightly bi-lobed. The anterior gland measures 0.17 to 0.22 mm. in length, 0.22 to 0.26 mm. in breadth, and about 0.19 mm. in thickness, while the posterior is 0.22 to 0.26 mm. in length, 0.24 to 0.28 mm. in breadth, and 0.22 to 0.24 mm. in thickness. The vas efferens, arising at the posterior ventral edge of the anterior testis, passes forward around the gland and forms a reservoir between the testis and ovary. From this enlargement the duct passes posteriad beneath this testis and between the lobes of the posterior testis to the large vesicula seminalis. A short duct from the posterior

testis empties immediately into the vesicula seminalis. The vesicula seminalis is coiled and is connected with the genital pore by an ejaculatory duct.

The ovary is located slightly to the left of the median line about one-third of the distance from the anterior end of the caudal region. It has a length of 0.08 to 0.1 mm., a breadth of 0.9 to 0.1 mm., and a thickness of 0.09 to 0.12 mm. The oviduct arises at the medio-posterior edge of the ovary and passes latero-posteriad for some distance. Laurer's canal is given off and passes more or less directly to the dorsal surface, lateral to the ovary. A small seminal receptacle is connected with the oviduct, near the point of origin of Laurer's canal. The oviduct passes posteriad around the dorsal edge of the anterior testis to Mehlis' gland and the ootype. Mehlis' gland is a group of cells held together by a network of connective tissue cells. This mass of cells is more or less compact and forms a framework around the ootype. As the oviduct emerges from the ootype it becomes the uterus and turns laterad and cephalad, extending past the ovary for some distance, where it bends back on itself and passes almost in a direct line to the posterior end of the body where it terminates in the genital pore.

The vitellaria are numerous. They have a more definite structure in this species than in *H. garium*. The outlines of the glands are distinct. They are generally distributed throughout the caudal region, especially posterior to the testes and anterior to the ovary. The latter area being almost completely filled with the glands. In the cephalic region the vitellaria are generally distributed posterior to the adhesive disc and gradually become fewer in number and disappear before they reach the ventral sucker. The vitelline material is collected into the vitelline reservoir which is located between the testes. A vitelline duct passes from the reservoir and empties into the oviduct in the region of the ootype.

Eggs are thin shelled and are few in number, usually not more than a dozen. They range in length from 99 to 110 $\mu$  and 60 to 66 $\mu$  in diameter.

Host: *Larus delawarensis*.

#### DISCUSSION

*Hemistomum confusum* apparently bears some resemblance to the European species *H. podomorphum* (Nitzsch). It was impossible to secure certain literature on the latter species and a comparison of the brief accounts by Diesing (1850:311) and Lühe (1909:160) throws very little light on the matter. In their accounts the principal characteristic of the species is the position and angle of attachment of the cephalic and caudal regions. Among the specimens of *H. confusum*



only an occasional, more or less distorted, individual bears any resemblance to a "human foot" (Fig. 6). The descriptions of *H. podomorphum* are inadequate, but on the whole, the differences in structure between the two forms appear great enough to warrant designating the American form as a new species.

*Strigea aquavis* differs from the other species of this genus in size, shape of the body, the relative sizes of the suckers, and the distribution of the vitellaria.

*Hemistomum gavium* differs from other species in the relative sizes of suckers and the distribution of the vitellaria.

The life histories of these forms are entirely unknown.

#### SUMMARY

*Strigea aquavis* n. sp. is described from the loon (*Gavia immer*) and the ringbilled gull (*Larus delawarensis*).

*Hemistomum gavium* from the loon and *H. confusum* from the ring-billed gull are described as new species.

These forms were taken in Oklahoma from migratory birds.

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## EXPLANATION OF PLATES

*Abbreviations*

AD, Adhesive disc	OS, Oral sucker
AG, Adhesive gland	P, Pharynx
E, Egg	SD, Suctorial disc
ED, Ejaculatory duct	SR, Seminal receptacle
EJP, Ejaculatory pouch	S, Seminal reservoir
EX, Excretory pore	T, Testes
EXC, Excretory canal	U, Uterus
GC, Genital cone	V, Vitellaria
GP, Genital pore	VA, Vagina
I, Intestinal crura	VD, Vas deferens
L, Laurer's canal	VES, Vesicula seminalis
LS, Lateral suctorial cup	VR, Vitelline reservoir
O, Ovary	VS, Ventral sucker
OO, Ootype and Mehlis gland	

## EXPLANATION OF PLATE IV

Figs. 1 and 2.—Reconstruction of *Strigea aquavis*.  $\times 45$ ; 1, side view; 2, dorsal view.

Fig. 3.—*Strigea aquavis*, toto mount, dorsal view.  $\times 45$ .

Figs. 4 and 5.—*Hemistomum confusum*, toto mount.  $\times 43$ ; 4, dorsal view; 5, ventral view.

Fig. 6.—Partial reconstruction of *H. confusum*, side view.  $\times 43$ .

Fig. 7.—Section through adhesive disc, *H. confusum*.  $\times 160$ .

GUBERLET—NEW HOLOSTOMIDAE

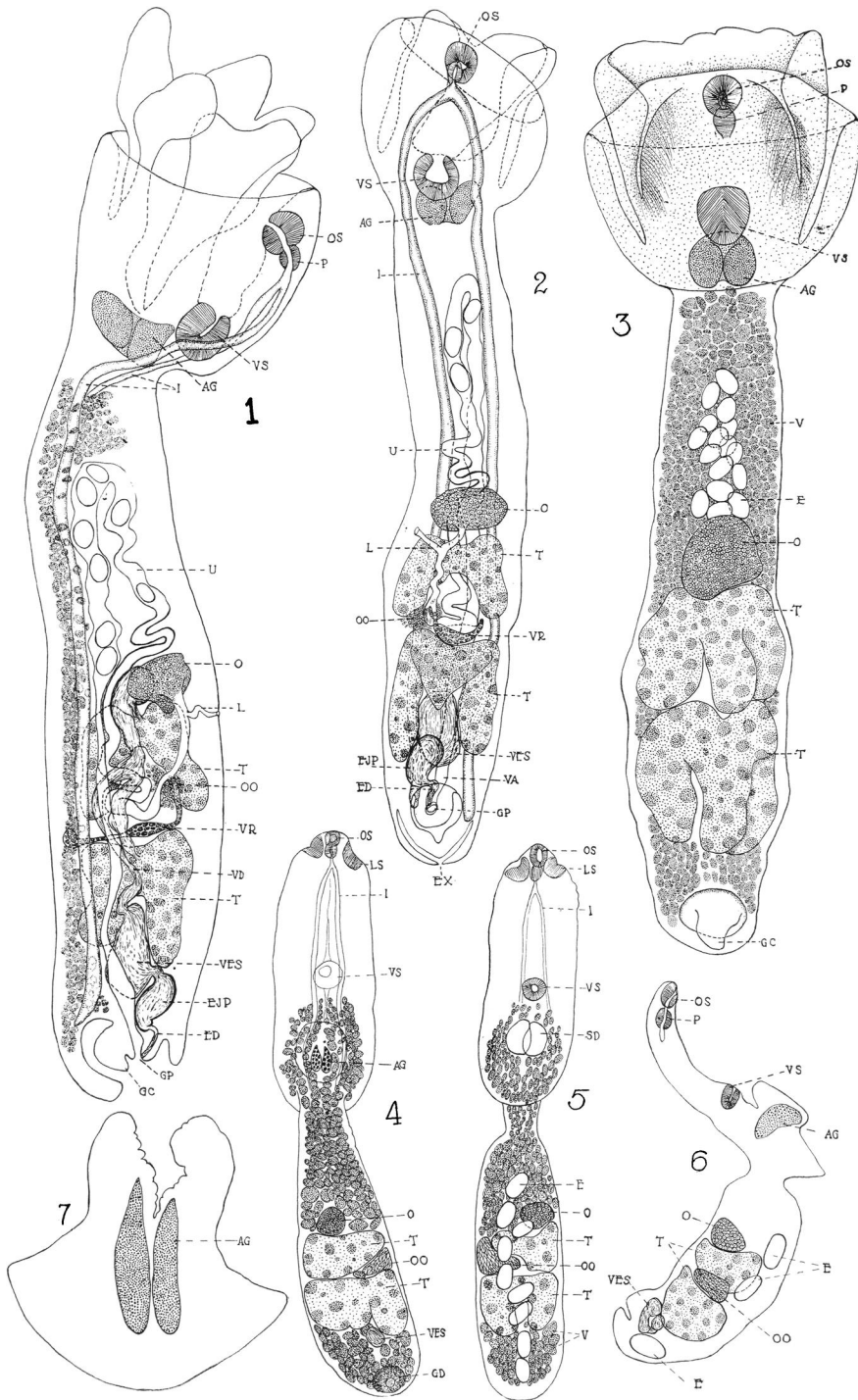


PLATE IV

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EXPLANATION OF PLATE V

Figs. 8 and 9.—Reconstruction of *H. confusum*.  $\times 120$ ; 8, dorsal view; 9, side view.

Figs. 10 and 11.—*H. gaviium*, whole mount.  $\times 92$ ; 10, side view; 11, dorsal view.

Figs. 12 and 13.—*H. gaviium*,  $\times 92$ ; 12, reconstruction from side view; 13, dorsal view.

GUBERLET—NEW HOLOSTOMIDAE

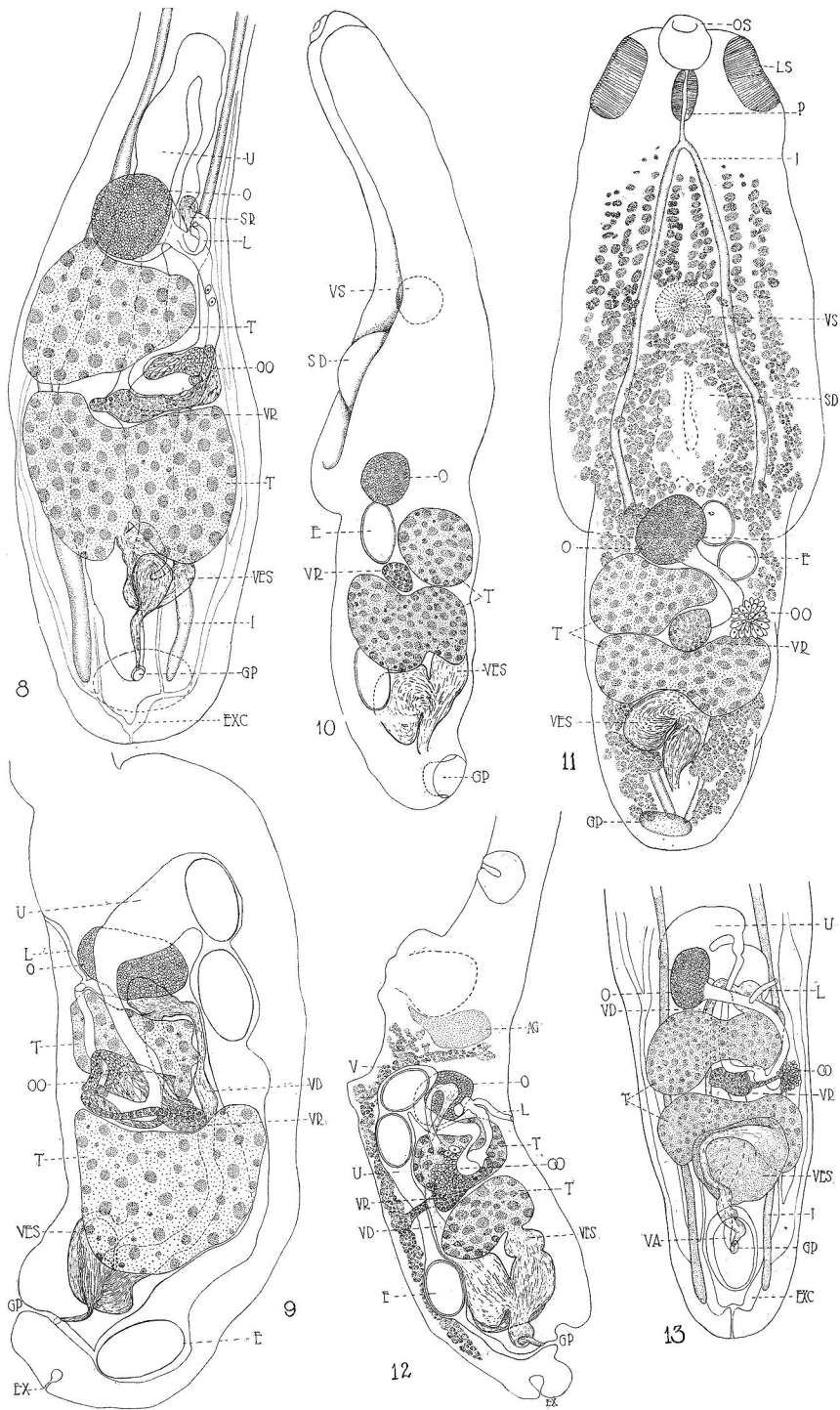


PLATE V